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RECOGNITION OF THE GEOLOGIC FRAMEWORK OF PORPHYRY
DEPOSITS ON ERTS-1 IMAGERY

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16. Abstract <p>Photo interpretation methods have been most successfully applied in the less vegetated test sites where several previously unknown geologic features have been recognized and known ones extended. Northwest trending mid-Tertiary faults in the Ely, Nevada area are observed to offset north-trending ranges and abruptly terminate older Mesozoic structures. In the Ray, Arizona area the observed patterns of fault and fracture systems appear to be related to the locations of known porphyry copper deposits. In the Tanacross, Alaska area a number of regional circular features observed may represent near surface intrusions and, therefore, permissive environments for copper porphyries.</p>			
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PREFACE

- a) Objective: The investigation is examining the general hypothesis that mineral deposits of the copper/molybdenum porphyry type occur in a characteristic geologic setting which is recognizable in the surface data presented on a space-acquired imagery.
- b) Scope of Work: ERTS-1 imagery obtained over six test sites selected to represent a variety of physical environments and ages, as well as a range of "levels of knowledge," are being studied by conventional aerial photo interpretive methods and by the use of optical image enhancement techniques. The compilation of available public and "in-house" information on each site to construct a readiness file has been completed. A "naive" conventional interpretation of imagery over each test site (i.e., without reference to the readiness file) has been accomplished by an outside contractor, Earth Satellite Corporation, the purpose being to compare the information which can be obtained from the imagery with that already known, one method of obtaining a relatively unbiased evaluation. Comprehensive interpretations of the imagery over each test site using all information available, including aeromagnetics and the use of image enhancement techniques to produce a map folio treating magnetic characteristics, metallogenics, lithology, tectonics and hydrothermal alteration have been initiated.
- c) Conclusions: Supplementary map information obtained by conventional aerial photo interpretive methods is available from ERTS-1 imagery, chiefly in less vegetated areas. Low sun angle and synoptic coverage are particularly valuable in disclosing previously unrecognized linear features expressed in the topography. A light snow cover enhances subtle linear features.
- d) Recommendations: None

INTRODUCTION

This report covers the progress of the subject investigation for the period January 1 to June 30, 1973. During this period "naive" interpretations (i.e., without consulting the readiness file comprising public and in-house information) of the ERTS imagery for the six test sites were completed by Earth Satellite Corporation, an outside contractor. They have also initiated work on optical enhancement of selected scenes. Photo mosaic laydowns have been made of the Ray, Arizona and Tanacross, Alaska test sites. Photo interpretations of the underflight color infrared aerial photography have continued through the period. Comprehensive interpretations of the ERTS imagery over the test sites utilizing all available information have been initiated by our co-investigators. Upward continuation of low level aeromagnetic surveys

at the SW USA test sites to allow mosaicing on a common base with USGS high altitude survey results has been completed for two Ely, Nevada area surveys.

MAIN TEXT

The "naive" interpretations of ERTS imagery over the six test sites have been completed by Earth Satellite Corporation, an outside contractor, the purpose being to produce interpretations which can be compared to known information from published and company sources to ascertain the new information available in the space-acquired imagery and also that which is known but not evidenced. A meeting of co-investigators with EarthSat had been scheduled to "score" the naive interpretations against the readiness file material during the reporting period but was deferred to a later date owing to conflicts. Mini Adcol-combined color composites of the test site imagery facilitates the mapping of tectonic and hydrothermal features.

Photo mosaic laydowns of the ERTS imagery over the test sites are being constructed to facilitate compilation of ERTS 1:1,000,000 scale information with readiness file information. This has been completed for the Tanacross, Alaska and Ray, Arizona sites. Underflight aircraft color infrared photography in the Ray, Arizona and Ely, Nevada test sites is being interpreted. It has been found to have high resolution and characteristics which permit the discernment of more subtle differences in lithology and hydrothermal alteration than is observable in conventional aerial photography. An example is the discernment of bedrock inliers in alluviated desert valleys.

Existing aeromagnetic information is to be used to help assist in the interpretation of features observed in the ERTS imagery. In-house low level surveys are being upward continued by computer methods to supplement USGS high level surveys. This was completed for two surveys in the Ely test site area during the reporting period.

Comprehensive interpretations of imagery over the test sites is in progress for the Ely, Ray, Tanacross and Ok Tedi test sites. Use of a stereo viewer on the side-lap ERTS coverage enables the determination of the direction of dip of sedimentary beds and throw of faults and other geologic parameters, particularly in areas of high relief and arid climate. Interpretation of imagery over low-relief and heavy vegetation such as the Mt. Perry, Queensland, Australia test site yields comparatively little information.

- 1) Ely, Nevada Test Site -- Three geomorphic provinces are evident as is the west-northwest Las Vegas shear zone. The Sevier, Hurricane and Grand wash faults can be traced further on the ERTS imagery than they are shown on published maps. A northwest set of steeply dipping faults is observed

to offset the north-trending ranges and abruptly terminate older Mesozoic structures. Oligocene volcanics are preserved in the grabens. Most of these linear physiographic features are related to mid-Tertiary or later events. Circular features define late Tertiary calderas and similar appearing remnants of extensive ash flows.

- 2) Ray, Arizona Test Site -- The ERTS imagery of this test site displays three general structural trends that can be further sub-divided into other systems. Correlations of these fault systems to the Wasatch-Jerome, Front Range Orogens, Texas Zone, and the Basin and Range Province is possible. The patterns of fault and fracture systems are presently being interpreted in regard to the role they play in intersecting at locations of known porphyry copper deposits. Because of the arid climate and lack of vegetation, numerous lineations can be detected on the ERTS imagery compared to the few mapped lineations from Ok Tedi, Papua that is mostly jungle.
- 3) Silverton, Colorado Test Site -- Owing to excessive cloud cover on the ERTS imagery over the original Leadville, Colorado test site the location was changed early in the year to center on Silverton, 120 miles southwest. Consequently, the receipt of imagery and its interpretation lags somewhat behind the other U.S. areas. Two major fault systems trend N10E and E-W. Several circular features observed may be the result of the near surface intrusions. January imagery with light snow cover reveals some subtle features not recognizable on the September imagery over the same areas.
- 4) Tanacross, Alaska Test Site -- The ERTS imagery of this area has prevailing NW-SE structural trends in the vicinity of the Denali fault. A number of regional circular structural features occur that could be surface expressions of near surface intrusions. If so, these localities would be good exploration targets for porphyry copper deposits. This area due to the mountainous topography, regional geological structures and average vegetation cover is an area that easily lends itself to photogeology interpretation.
- 5) Mt. Perry, Australia Test Site -- Due to the extensive agriculture development in the valleys of this test site, it is difficult to do photogeology in many places on the ERTS imagery of this test site. Most of the lineations and bedding have a strong NW-SE trend. Large sand dunes can be mapped as distinct lithological units.
- 6) Ok Tedi, Papua Test Site -- This test site due to the tropical location and its dense vegetation, is a difficult location to do photogeology interpretations on ERTS imagery. In the lower topographic areas there are very few

indications of the bedrock geology; however, the mountains in the northern portion of the test site enable strike and dips to be mapped on the ridge outcrops.

A "level of knowledge" assessment of each of the test sites has been made to provide a basis for evaluating the effect of the amount of prior knowledge on the amount, type and quality of information gained from the ERTS imagery over the respective test sites. Level of knowledge is based on amount, accuracy, completeness and scale of information available or known and includes published and unpublished sources. Obviously, one individual's level of knowledge of a given area is greater or less than another's. Consequently, a general level of knowledge available to, or held by, the investigators as a group is estimated on an arbitrary scale of 1 to 10, 1 being complete naivety and 10 a complete detailed knowledge; neither end member being conceivable.

Level of Knowledge

Ray, Arizona	9
Ely, Nevada	8
Silverton, Colorado	6
Tanacross, Alaska	4
Mt. Perry, Australia	2
Ok Tedi, Papua-New Guinea	2

UNDERFLIGHT AIRCRAFT SUPPORT

Inquiry was made from NASA as to additional aircraft support coverage that might be desirable and in response two areas in Arizona and one in Nevada were recommended using aerochome infrared film (2443) in the RC-10 camera. This combination has proven to be most useful in deciphering arid region geology. The aircraft support has been adequate and timely furnished.

PRACTICAL APPLICATIONS

The ERTS imagery has obvious application as a source of supplemental information in previously mapped areas and as a source of reconnaissance information in virgin areas. The imagery yields most geologic information in areas of sparse vegetation and least in areas of low relief and heavy vegetation. Contacts between contrasting rock units, major structural features producing strong regular patterns such as faults and fractures expressed as linears or caldera and breached anticlines expressed as rounded features are fairly obvious. Additional interpretive work utilizing optical image enhancement, aeromagnetism and more detailed standard aerial photo techniques is expected to reveal more subtle information.

COSTS/BENEFITS

An analysis of costs/benefits is not feasible at this point. An obvious benefit to be derived from ERTS imagery is in their use for preliminary office evaluation of little known areas and as base maps for reconnaissance work. Inasmuch as this is information that would not otherwise be obtained it would be difficult to quantify the benefits.

PROGRAM FOR THE NEXT REPORTING PERIOD

Interpretation of the ERTS imagery using all available information, conventional aerial photo interpretation techniques and optical image enhancement methods will continue through the next reporting period. Contingent on co-investigator's schedules, a meeting with EarthSat to score their naive interpretations will be combined with the earlier planned meeting to review progress in optical image enhancement and to apply it to selected problem areas. The results of the scoring will be reported in a "Quick Look Report". Additional low level aeromagnetic surveys will be reviewed for computerized upward continuation.

CONCLUSIONS

Supplementary map information obtained by conventional aerial photo interpretive methods is available from ERTS-1 imagery, chiefly in less vegetated areas. Low sun angle and synoptic coverage are particularly valuable in disclosing previously unrecognized linear features expressed in the topography. A light snow cover enhances subtle linear features.

RECOMMENDATIONS

None